HOT SPOT!

Grade 4

Essential Question

How was the Hawaiian Island chain formed? (scientific and cultural perspectives)

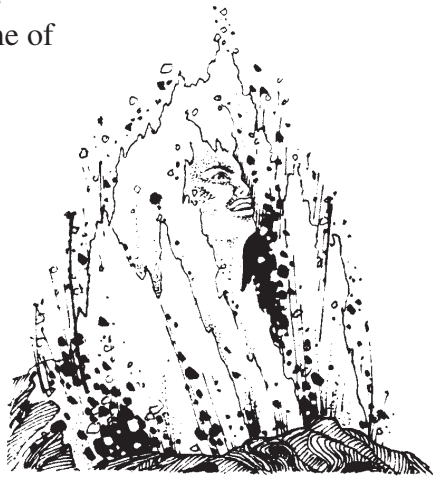
Hawaiʻi Content Standards and Performance Indicators

Science**:** Forces That Shape the Earth

- Describe the causes and effects of volcanoes. (Hawaiian Island chain)

Social Studies**:** Historical Perspectives and Interpretations

- Describe events that show different perspective or frame of reference (point of view).
- Identify and describe some of the beliefs/values and education/learning of pre-contact Hawaiʻi.



Social Studies**:** Physical Systems

- Explain the formation of volcanic islands.

Key Concepts

- According to the hot spot theory, the Hawaiian volcanoes are caused or formed when the Pacific plate moves over a hot spot. The effect of this volcano formation is a chain of islands that extends from the Lōʻihi Seamount in a northwesterly direction to the oldest Emperor Seamount.
- According to some Hawaiian *moʻolelo*, the Hawaiian Islands were formed when Māui pulled them up with his fish hook and secondary cones were formed when Pele dug them with her *ʻōʻō* (digging stick).

Activity at a Glance

Students compare Hawaiian *moʻolelo* (myths, legends) to the hot spot theory regarding the formation of the islands.

Assessment

Students complete a hot spot matrix and student activity sheet.

Exploring the Islands Telecast: "On the Hot Spot"

Students from Keaukaha Elementary School visit the "Hot Spot Cafe," home of "tectonic plate specials," where they learn about the plates that make up Earth's surface. Terry Reveira, Education Specialist for Hawai'i Volcanoes National Park, shares *mo'olelo* (stories) about the volcano and presents Hawaiian protocol. During the program, students will simulate the formation of the Hawaiian Island chain over a stationary hot spot using a sheet of acetate and raisins.

Time

four class periods

Materials/Resources

Pacific plate map (provided)
hot spot matrix—one per student (provided)
student readings—one per student (provided)
student activity sheet—one per student (provided)
colored markers
one small knife
one hard boiled egg

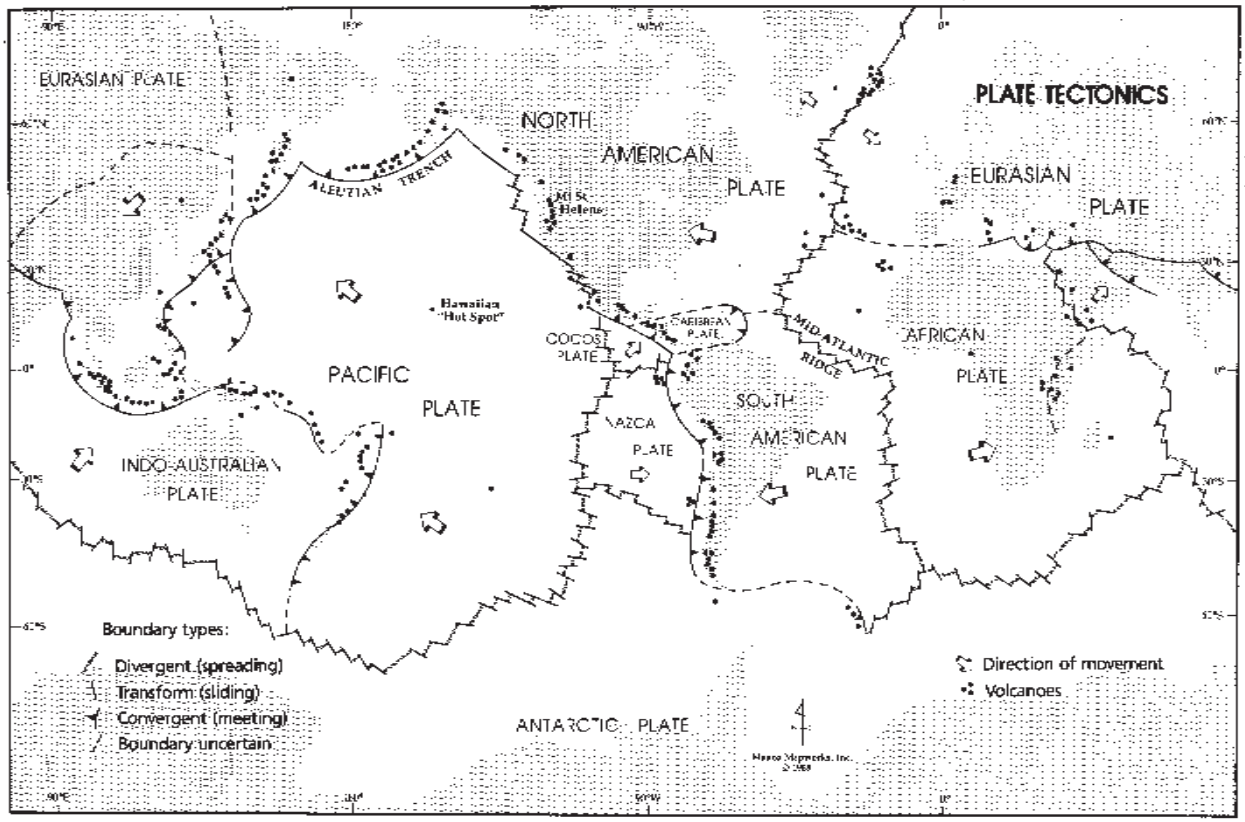
During the *Exploring the Islands* telecast—one per student:
- one sheet of acetate
- small red paper cut out in a circle about 1 in. in diameter to be taped to desk (or washable red mark on desk)
- small box of raisins

Vocabulary

shield volcano, core, mantle, crust, hot spot, Pacific plate, ring of fire, *mo'olelo*, lithosphere, plate tectonics

Teacher Background Information

The structure of the Earth can be compared to a hard-boiled egg, where the yolk represents the core, the white represents the mantle, and the shell approximates the crust. The Earth's **core** is approximately 3,500 km (2,200 mi) thick and consists of a solid inner core and a fluid outer core. Surrounding the core is the solid rock of the **mantle**, about 2,900 km thick (1,800 mi), where molten material exists in hot spots, subduction zones and spreading centers. The thin **crust** of the Earth is about 5–40 km (3–25 mi) thick. It is thicker beneath the continents than the oceans. The Earth's **lithosphere** (crust and uppermost mantle) is divided into large plates that fit together like a giant puzzle. While they appear to be stationary, they are actually moving very slowly and interacting in three ways: 1) they spread apart at mid-oceanic mountain and continental rifts; 2) they collide (forming mountains or bending under one another); and 3) they grind past one another, such as along the San Andreas fault



in California. The theory that describes the dynamic movement of these plates is known as **plate tectonics**. (Refer to map of Earth's plates above.)

The interaction between plates creates zones of seismic (earthquake) and volcanic activity at the plates' boundaries. The Pacific Ocean is surrounded by such a zone, known as the "**ring of fire**." As the Pacific plate moves toward the northwest, it bends and is subducted in the Japan, Kamchatka, and Aleutian Trenches near the Eurasian continental plate. This movement creates earthquakes along the trench and active volcanoes along the plate boundary.

The Hawaiian Islands are located on the **Pacific plate**. According to the **hot spot** theory, the **shield volcanoes** of the Hawaiian Islands are formed as the Pacific plate moves over a stationary hot spot, located in the general area of the island of Hawai'i. Over thousands of years, volcanoes erupting over the hot spot accumulate enough mass to rise above sea level and become islands. As the plate moves to the northwest, new islands form over the hot spot.

Secondary volcanic activity (rejuvenation) occurred on most of the islands when volcanoes were approximately 150 km (90 mi) away from the hot spot.

Mo'olelo are narratives about Hawaiian traditions and legends. According to one Hawaiian legend, some of the Hawaiian Islands are the children of Papa, the earth mother, and Wākea, the sky father. Mutual jealousies led to an embittered relationship between Papa and Wākea. An affair between Wākea and the goddess Hina produced the island of Moloka'i, and in

retaliation, the embrace of Papa and the warrior Lua resulted in the birth of O‘ahu. The *mo‘olelo* included in this activity relate the story of Māui pulling up the islands and Pele digging the pits that represent secondary volcanic activity. Hawaiians were keen observers of nature and, from the *mo‘olelo* of Pele, we can see that they were probably aware of the age progression of the islands. Pele visited Ni‘ihau, the oldest of the main islands, first and then moved down the chain until she reached the island of Hawai‘i where she now resides. On Hawai‘i, Pele is associated with building primary shield volcanoes instead of secondary activity cones.

Teaching Suggestions

1. Crack and peel an egg and save the eggshell pieces. Cut the egg in half and review the structure of the Earth, comparing the core and mantle to the parts of the hard-boiled egg. Compare the cracked eggshell to a “cracked Earth shell” that is composed of approximately 12 major plates.

2. Distribute the Pacific plate map to students. Point out the hot spot and explain that, unlike the eggshell, the earth’s plates are moving.

3. Ask students to guess how fast we are “riding” on the Pacific plate. Then compare the plate’s movement to the growth rate of students’ fingernails—approximately 10 cm (4 in.) per year.

4. Have students follow the Hawaiian chain up to Midway and then all the way to the Emperor Seamounts, which extend to where the Pacific plate goes beneath the Eurasian and North American plates. Explain that the bend in the island chain is thought to be due to a change in the plate’s movement. Point out where new crust is formed along the oceanic ridge at the southeast portion of the Pacific plate.

5. Explain that the movement of the plates causes volcanoes and earthquakes to occur at the plate boundaries. Distribute the matrix and ask them to fill in the first two columns on wondering and predicting.

6. Discuss students’ ideas about how the Hawaiian Islands formed in the center of the plate.

    - Where did the lava that built our volcanoes come from? (*It comes from the hot spot in the mantle beneath the ocean floor.*)
    - Which of the Hawaiian Islands is currently over the hot spot? (*Big Island*) How do you know? (*It’s the site of active volcanoes.*)
    - Were the other islands once over the hot spot? If so, how did they move away from it? (*Yes, the islands are slowly “riding” away from the hot spot on the Pacific plate to finally sink beneath the surface.*)

7. Have the students read the two *mo'olelo* provided and summarize or illustrate (with written explanation) how the early Hawaiians explained the formation of the islands.

8. Watch the *Exploring the Islands* telecast ("On the Hot Spot"). Have the materials ready for students to simulate the formation of the Hawaiian Island chain with the acetate and raisins.

9. Following the telecast, have students work individually or in groups to complete the matrix and then share their work.

10. Distribute the student activity sheet and ask students to use their matrices to answer the questions.

Extended Activities

- Create Earth models using musubi balls.

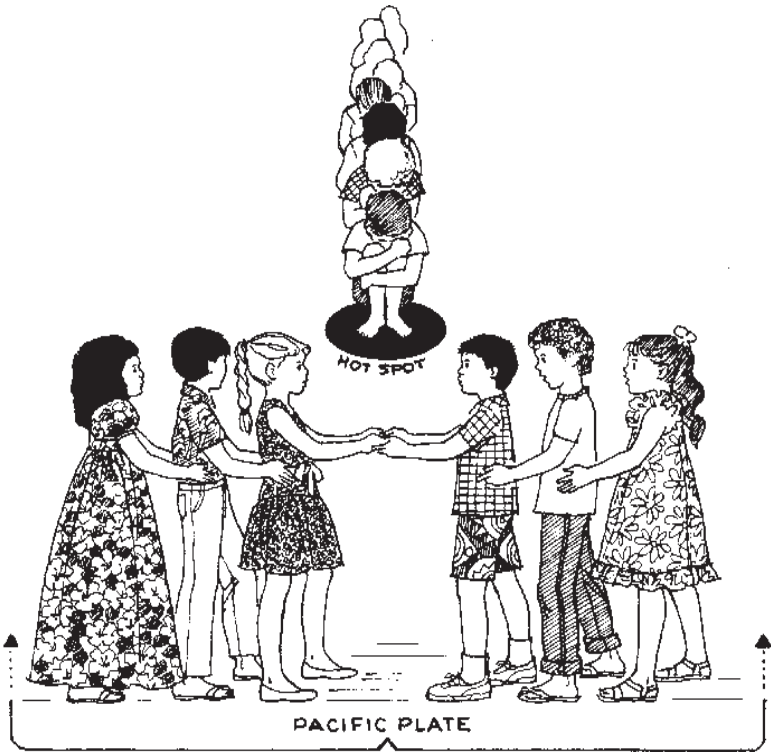
  Ingredients
  Rice: ½ cup cooked per student (*mantle)*
  Ume: one per student (*core)*
  Nori: ½ sheet per student (*crust)*
  Furikake: 1 jar (*islands)*
  Zip-lock sandwich bag: one per student

  Process
  1. Place ½ cup cooked rice in each bag
  2. Have the students shape it into a ball shape. Explain to the students that this is the Earth's mantle.
  3. Pass out the *ume* and have them put it into the center of the rice ball. Reshape the rice ball. Explain to the students that this is the Earth's core.
  4. Tear the *nori* into 12 pieces, moisten the *nori*, and place over the rice ball They will overlap. Explain to the students that this represents the Earth's 12 major plates.
  5. Sprinkle *furikake* on the Pacific plate *nori*. Eat and enjoy.

  (Source: Hawaii Geographic Alliance)

- To reinforce the hot spot theory, have students act it out! (Refer to illustration on the following page.) Place a red paper circle in the center of the floor to represent the hot spot. Have eight students represent the main islands waiting to be formed by kneeling around the hot spot. The remainder of the class could form the Pacific plate (see illustration). As the plate moves slowly over the hot spot, the islands should pop up successively from Ni'ihau to Hawai'i. When each island pops up, it should move slowly with the plate and gradually assume a lower posture to indicate erosion and sinking. Have the plate continue moving toward the northwest carrying the islands along, until they reach a wall that could represent the edge of the continental plate.

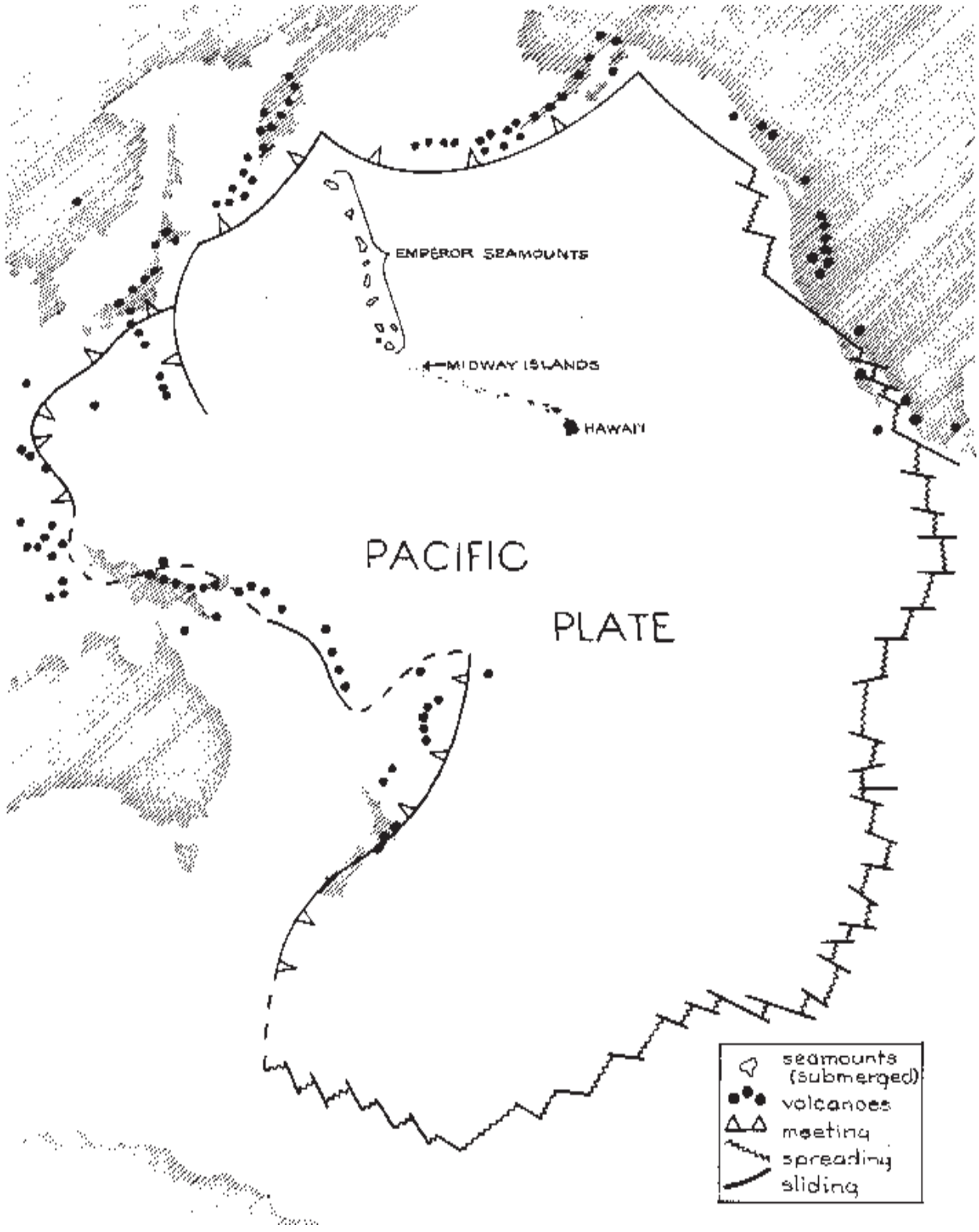
- Use creative dramatics to represent the Earth's core, mantle and crust with magma coming



up through a hot spot to become lava. Have two or three children compact themselves into a solid core and be surrounded by "liquid" children representing the outer core mantle. Students representing the crust should hold hands and stretch around the mantle. Have two children drop hands at a point designated the hot spot, and have one or two children representing magma from the mantle emerge to the outside of the crust as lava.

- Show the geology video ("Hawai'i and Planet Earth: The Hawaiian Geology," *Science in Hawai'i*, ITV No. 7) and discuss the formation of the Hawaiian Islands. If the video is not available use the diagram on page 11 for your discussion.

Hot Spot: Pacific Plate Map



Hot Spot: Matrix

	Wondering	Predicting	Reflecting	Retelling
 Hot Spot				
 Pele				
 Maui				

(source: Torry Montes)

Moʻolelo o Māui

One fine sunny day, Māui and his brothers went fishing. They paddled their canoe far out to sea. Māui took out his special bone fishhook and prayed to the gods to make it very powerful. The winds blew softly around the canoe as it floated over the rolling sea. The brothers patiently waited for the fish to come.

They watched the sun climb higher and higher in the sky. They grew tired. *Auwē!* Where were the fish? After many hours had passed, the brothers decided to head for home. They were disappointed as they turned their canoe around and paddled toward shore. After they had paddled for a while they felt a strong pull on the canoe. Could they have caught a fish at last? Perhaps Māui's special hook had brought him luck!

The brothers became very excited and paddled faster and faster. Their arms grew tired. Whatever Māui had caught was very strong and very big! They began to wonder what could possibly be on Māui's hook. They were frightened by the thought of a huge, powerful fish. They begged Māui to cut the fishing line, but Māui refused and ordered his brothers to look straight ahead and continue paddling.

It took all of Māui's strength to hold on to the fishing line. His special fishhook had not failed him. What a fish he must have! His tired brothers no longer cared about the fish and wished Māui would cut the line. With aching arms, they kept on paddling and looked only to the front of the canoe.

Māui continued to pull on the line as hard as he could. But he soon realized there was no fish on the end of the line—it was land! As he pulled, he watched land rise slowly out of the sea! Māui was filled with wonder and excitement! With his powerful fishhook, he had caught a huge mass of land. Never had he caught anything so large! The brothers sensed Māui's excitement, but still they looked only to the front of the canoe.

Finally, one of Māui's brothers could stand it no longer. His tired muscles ached and he wanted to know what Māui had caught. As he turned to look, Māui lost some of the catch! Instead of a great mass of land, all he had was a group of islands. But what beautiful islands they were! And that, so the legend says, is the way our Hawaiian Islands came to be.

Mo‘olelo o Pele

Pele came to the Hawaiian Islands from a faraway land. She had quarreled with her powerful sister, Nāmakaokaha‘i, a goddess of the sea. After their quarrel, Pele left to find a new home.

Pele went to Ni‘ihau and dug a deep pit in a mountaintop with her *‘ō‘ō*. She created a volcanic cone with a pit or crater inside it. She liked the hot fires. But her sister, Nāmaka, the sea goddess, followed Pele and destroyed her fiery home with the ocean waters.

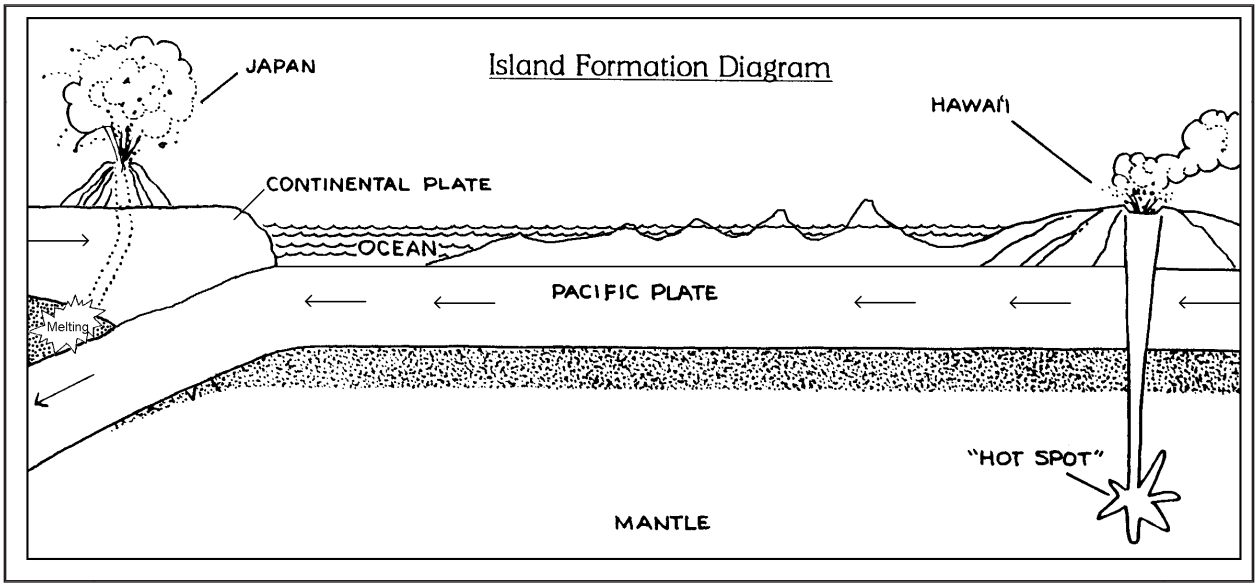
Angrily, Pele fled to Kaua‘i. There she used her *‘ō‘ō* to dig a deep fiery pit. But again, the sea goddess followed her and put out the fire. Pele ran away to O‘ahu and dug a new home there. But the sea goddess destroyed it. Pele angrily left and tried to make her home in a fiery pit on Moloka‘i. Again, her sister, the sea goddess, destroyed it.

Pele fled to the island of Maui where she dug a deep fiery pit as her new home. Her sister followed her and destroyed her home once again. Pele was very angry and she and Nāmaka had a bitter quarrel. Pele was injured in the fight and left some of her bones on a hill in Hāna. Nāmaka thought she had finally stopped the fire-making of her sister, but she learned that the spirit of Pele had fled to the island of Hawai‘i.

On Hawai‘i, Pele, the volcano goddess, dug a deep, deep pit in the center of Kīlauea. In this fiery pit, Pele still makes her home. The island of Hawai‘i continues to grow. Will the sea goddess catch up with Pele once again?

(Adapted from: Jean Min, 1987, "Hawai‘i: Its Volcanic Beginnings," Honolulu, Kamehameha Schools.)

Hot Spot: Student Activity Sheet



1. Color the hot spot red, the Pacific plate brown, and the Hawaiian Islands green.

2. Using the hot spot theory, describe how the Hawaiian Island chain was formed.

3. How is the hot spot theory different from the Hawaiian *mo'olelo* about the formation of the Hawaiian Islands?

4. How is the hot spot theory similar to the Hawaiian *mo'olelo* about the formation of the Hawaiian Islands?